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Correlation Analysis of the Effect of Atmospheric Factors on the Negative Effect on the Health of the Population of Tijuana, Baja California, Mexico

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ABSTRACT

This investigation was made to determine the correlation analysis of the presence of the atmospheric factors as air pollution agents as sulfur dioxide (SO_2), nitrogen oxides (NO_X), ozone (O_3) and carbon monoxide (CO), and climatic parameters as relative humidity (RH) and temperature in the generation indices of lung cancer with death of pulmonary symptoms in the Tijuana city, which is considered as one of the most city contaminated in the Mexican Republic. Also were evaluated the health effects of persons in the skin as skin cancer detected in some persons of this border city, by the effect of the exposition for long time to the ultraviolet rays of sun, due to the deterioration of the ozone layer, which was detected by the ozone particles close to the ground surface in this city. In this city are presented air pollutants mentioned above, as the principal air pollutants and addition to the climatic factors as variations of relative humidity (RH) and temperature, were a negative effect n the health of population of this city, specially in the health symptoms mentioned above. To determine the relation of atmospheric factors and the occurrence of health symptoms mentioned above, was made an analysis with the Spearmen analysis. This scientific study was made in 2022.

Keywords: Atmospheric factors; Air pollutants; Climatic parameters; Health symptoms.

Introduction

In this investigation was evaluated the relation between the principal atmospheric factors mentioned above and the presence of the health symptoms as respiratory diseases and skin cancer, in the population of the Tijuana city, where was made a correlation analysis with statistical methods as the Spearmen analysis. The atmospheric factors mentioned above were evaluated in different periods of the 2022, where was made this scientific study, to determine the season where has presented the more negative effect in health of people of this industrial city, which is located in the northwest of the Mexican Republic. The care of the environment with social and health programs are very important in the environmental culture in each community, to avoid any negative effect on the health of humans, animals and plants, and the deterioration of the ecosystems (Bashir et al, 2020). The air pollution in this city that is considered as a border city, overpassed the air quality standards in the period of this scientific study.

Tijuana city

Is an industrial city with around 300 industrial companies from some countries being the principal Brazil, Canada, China, South Japan, Korea, Germany, Italy, Netherlands, Spain and United States of America (USA, being the neighbor of Mexico). The majorly of the products manufactured as from aerospace, agricultural, biomedical, electronic, metallic, plastics and textile industries, which generates some quantity of air pollutants of the chemical agents mentioned above (IMAQ-Tijuana, 2022).

In this city as the other big city (as Mexicali city) in the Baja California State where is located the Tijuana city, are considered the most contaminated cities in the Mexican Republic, without an environmental culture program and having a lot experts in the health environmental. In figure 1 is showed the location of this city in our country. This

concerns to the governmental authorities, where have some environmental culture as special programs to avoid the generation of the air pollination, where is supplied from car vehicles (with more than 500, 000 cars) and added to the 300 industrial companies mentioned (G. Lopez et al, 2015), originates in some periods of the year (specially in the winter season), where is formed the greenhouse effect. This physicochemical phenomenon causes that the chemical agents as air pollutants, up to the atmosphere and down to the land surface and originates a bad effect in the health symptoms of population of this industrial city, and also animals and plants, and the deterioration of the ecosystems of this region of the Mexican Republic.

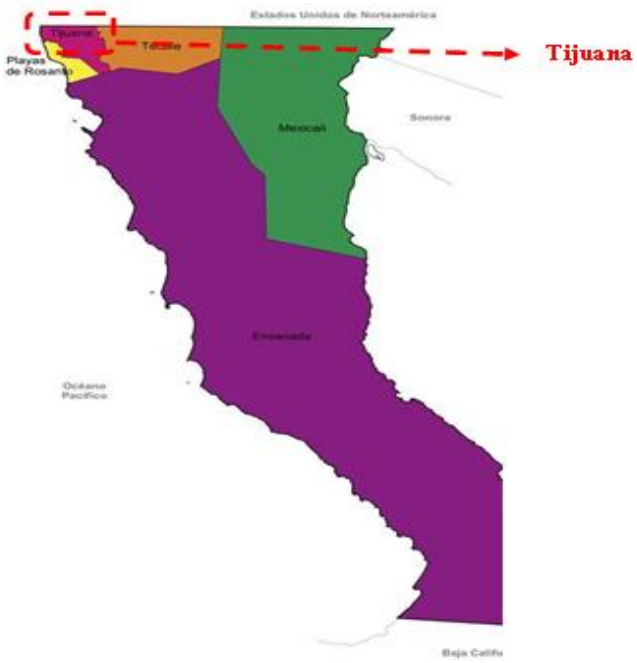

Figure 1. Location of the Tijuana city in the Mexican Republic

SOURCE: Analysis of the investigation

Air pollutants

The chemical agents are generated by the physicochemical process in car vehicles and industrial companies, where in cars are from the combustion action to turn on and use of this type of vehicles, and of the industrial companies of some industrial process in he manufacturing, where in sometimes this occurs because not have a total control of the industrial activities (Leung, 2020). The principal air pollutants mentioners above, penetrates by respiratory tract and are deposited in some parts of the human body in the skin, and persons that are exposed for long periods of times, as people who works in streets in outdoors or works in input places as close buildings, can suffer of damage n this his skin and can generates the skin cancer, which is a serious health symptom actually (Cui et al, 2018).

Climatic factors

These factors are very relevant in the dispersion of the air pollutants, being the most important the temperature (measured normally in centigrade grades, °C) and relative humidity (measured in percentage, %) (Adach et al, 2020). Also, in some scientific studies are considered the rainfall where occurs principally in the autumn (September and October) and winter (from November to February), in this industrial city. It is also considered the

wind flow (direction and speed) to have an analysis of the dispersion of air pollutants, which are emitted by the two principal sources mentioned above (car vehicles and industrial companies). In this scientific study was considered only the temperature and relative humidity (RH) (Anyanwu et al, 2018), as the principal climatic factors that have a negative effect added to the chemical agents as air pollution phenomena, in the health and the main healthy symptoms of the population of the Tijuana city, where was made this investigation.

Health symptoms

The air pollution generates some health symptoms, which is depending of the type of chemical agent as air pollutant and the time of the exposition. It is well known that a lot persons in these times, where continues the presence of the Covid19 and before the appearance of this health symptom, are in streets as outdoor places, are without protection as facemask, and are exposed for long times in outdoor places and not care its health (Bernardini et al, 2020).

Also, the air pollutants generated in this industrial city, overpass the air quality standards (AQS) with levels higher each day, which are registered and regulated by the Secretaria de Medio Ambiente y Recursos Naturales (SEMARNAT-Mexico) and the Environmental Protection Agency (EPA-USA, and in sometimes of the year are uncontrolled. This generates some diseases, being the principally the respiratory and skin diseases, being a relevant factor in the health of the population of this important city of the northwest of Mexico (SSA, 2022).

Spearman analysis

This statistical parameter is very relevant to determine the relation of variables (being one variable as independent aspect and other variable as depend of other variable), and can take a good decision in any type of activity. Has been used in the lot quantity of scientific studies and was supported to improve any type of actions. This statistical parameter is easy to obtain and have a great revelation in all investigations and to take the good decision and avoid any type of complicated situation (Huang et al, 2020).

Methodology

In this investigation was made some actions to determine the relation of the air pollution generated by car vehicles and industrial companies in this industrial city and the generation of health symptoms as respiratory diseases and skin cancer. To make this action was made the next activities:

(a) Evaluation of the main air pollutants in the Tijuana city.

(b) Analysis of the climatic factors as temperature and relative humidity parameters in this industrial city.

(c) Evaluation of the health symptoms as respiratory diseases and skin cancer.

(d) Correlation analysis with the Cronbach coefficient.

Results

This scientific study showed relevant information with numerical data, where was illustrated in the next sections the interesting evaluations elaborated to determine the correlation of the air pollution and the occurrence of the health symptoms.

Evaluation of air pollutants

The evaluation of the air pollution factors was made to determine the emission process of the car vehicle that road by this industrial city and the industrial companies where is located in some strategic places of Tijuana city, but some industrial companies are located next to high ways of this city and was generated a combination, being very hard to the occurrence of the health symptoms mentioned above. In table 1 is showed the average air quality standards (AQS), which are described down of this table as a information regulated by Mexico and USA.

Table 1. Evaluation of air pollutants in the Tijuana city (2022)

Air Pollution Factors / **Periods of time**	**SO_2, ppm**	**NO_X, ppb**	**O_3, ppm**	**CO, ppm**	**Observations**
January	0.79	68	0.084	44	SO_2, NO_X, O_3, CO exceeds the AQS
February	0.67	62	0.079	41	SO_2, NO_X, O_3, CO exceeds the AQS
March	0.63	57	0.075	38	SO_2, NO_X, O_3, CO exceeds the AQS
April	0.58	55	0.071	36	SO_2, NO_X, O_3, CO exceeds the AQS
May	0.51	51	0.066	33	SO_2 exceeds the AQS
June	0.48	46	0.062	30	No contaminant exceeds the AQS
July	0.44	42	0.059	29	No contaminant exceeds the AQS
August	0.41	40	0.061	32	No contaminant exceeds the AQS
September	0.52	47	0.072	37	SO_2, O_3, CO exceeds the AQS
October	0.57	57	0.076	39	SO_2, NO_X, O_3, CO exceeds the AQS
November	0.64	60	0.079	42	SO_2, NO_X, O_3, CO exceeds the AQS
December	0.76	69	0.081	46	SO_2, NO_X, O_3, CO exceeds the AQS

Air Quality Standards (AQS) - https://www.epa.gov/criteria-air-pollutants/naaqs-table

SO_2. 0.5 ppm at 3 hours; NO_X. 53ppb at year; O_3. 0.070 ppm at 8 hours; CO. 35 ppm at 1 hour.

In the last table, was illustrated the air quality levels of the air pollutants mentioned above, where in the majorly of the months were exceeded the AQS, being a relevant aspect in the generation of the health symptoms. And in the section of observations are expressed the times that exceeded the AQS, being an interesting information. With this was observed the air quality of this industrial city in 2022.

Analysis of the climatic factors

These relevant factors were very important, because with the levels of temperature in some periods of the year, can be dispersed the air pollutants mentioned above, being an interesting aspect in the occurrence of the health symptoms mentioned above. The levels of temperature and relative humidity, caused the greenhouse effect, where

was increased the health symptoms and observed that by the air pollution the layer of ozone was destroyed in some places of the atmosphere of Tijuana city. This was relevant, because was monitoring the ozono levels at surface level of this city and was supposed it information, being in some places of Tijuana.

Table 2. Analysis of climatic factors as average level in the Tijuana city (2022)

Climatic Factors / Periods of time	Temperature, °C	Relative Humidity, %	Observations
January	11	67	Low Cold Weather
February	14	62	Low Cold Weather
March	18	58	Low Cold Weather
April	21	52	Medium Cold Weather
May	27	48	Hot Weather
June	32	45	High Hot Weather
July	35	56	High Hot Weather
August	33	59	Hot Weather
September	28	61	Medium Hot Weather
October	23	64	Medium Cold Weather
November	17	65	Low Cold Weather
December	13	68	Low Cold Weather

In table 2, is represented the principal climatic factors evaluated in this scientific study, where was illustrated the average levels by month, being relevant to the dispersion of he air pollutants evaluated, and described in the observations sections the periods of low cold weather, medium cold weather, hot weather and high hot weather. With this information can simulate a dispersion of the air pollutants analyzed and the occurrence of the health symptoms by zones in this city, being the zones with major occurrence of the lung cancer and skin cancer of population of Tijuana, the zones that are besides to the highways and where is installed the industrial companies in this industrial city.

Evaluation of the health symptoms

This interesting section of this scientific study was presented the average in percentage of the occurrence of the health symptoms evaluated, where was illustrated in table 3 that in the winter and autumn seasons increased the cases of these health symptoms. This was concerned to governmental area of health department, where was thinking about the causes by zones of the generation of the lung cancer and skin cancer, being relevant to take good and fast decisions to avoid the increase of these health symptoms.

Table 3. Evaluation of health symptoms as average level in the Tijuana city (2022)

Health Symptoms / Periods of time	Lung Cancer, %	Skin Cancer, %	Observations
January	50	56	Increase by the atmospheric factors
February	48	52	Increase by the atmospheric factors
March	53	47	Increase by the atmospheric factors
April	48	44	Increase by the atmospheric factors
May	42	40	Decrease by the atmospheric factors
June	40	37	Decrease by the atmospheric factors
July	39	33	Decrease by the atmospheric factors
August	33	38	Decrease by the atmospheric factors
September	41	41	Increase by the atmospheric factors
October	44	46	Increase by the atmospheric factors
November	48	50	Increase by the atmospheric factors
December	51	53	Increase by the atmospheric factors

In table 3, is showed the average percentage of the health symptoms evaluated, being important to determine the relation of the atmospheric parameters, and the realization of environmental and health programs to decrease these occurrences of the lung cancer and skin cancer. The generation of these health symptoms caused that people not assist to work to their work places as government as public aspect and industrial and commercial activities as private aspect, being a concern of directive and managers of these labor activities. If are healthy people, will be an optimal operative yielding in all labor activities.

Spearmen analysis

This statistic technique was made in this investigation to determine the grade of relation of presence of atmospheric parameters and the origination of health symptoms evaluated, as is mention in table 4 where was made this scientific study, and is illustrated the evaluation of the parameters mentioned.

Table 4. Analysis of generation of health symptoms by variations of atmospheric parameters in Tijuana city (2022)

Factors / Months	BMI, %	Hierarchy indices	AMI, %	Hierarchy indices	Dif=Abs (BMI – AMI)	Dif = Abs [(BMI – AMI)^2]
January	76	5	89	2	3	9
February	79	2	88	3	1	1
March	73	8	90	1	7	49
April	70	11	84	7	4	16

May	75	6	86	5	1	1
June	77	4	82	9	5	25
July	71	10	81	10	0	0
August	72	9	80	11	2	4
September	80	1	83	8	7	49
October	69	12	85	6	6	36
November	74	7	87	4	3	9
December	78	3	79	12	9	81
Total	894	78	1014	78	48	280

BMI - Correlation analysis of the effect of atmospheric parameters and occurrence of health symptoms before make this investigation. AMI - Correlation analysis of the effect of atmospheric parameters and occurrence of health symptoms After make this investigation.

Table 5. Analysis of generation of health symptoms by variations of atmospheric parameters in Tijuana city (2022)

Factors / **Months**	**Hierarchy indices**	**Hierarchy indices**	**Dif=Abs (BMI – AMI)**	**Dif = Abs [(BMI – AMI)^2]**
January	5	2	3	9
February	2	3	1	1
March	8	1	7	49
April	11	7	4	16
May	6	5	1	1
June	4	9	5	25
July	10	10	0	0
August	9	11	2	4
September	1	8	7	49
October	12	6	6	36
November	7	4	3	9
December	3	12	9	81
Total	78	78	48	280

BMI - Correlation analysis of the effect of atmospheric parameters and occurrence of health symptoms before make this investigation. AMI - Correlation analysis of the effect of atmospheric parameters and occurrence of health symptoms After make this investigation.

$r = \{1- [(6*48) / (12*(12^2-1)]\} = [1-(288/1716)] = 1-0.16 = 0.84.$

As is major of 80% the r, this indicates that the correlation of the presence of atmospheric parameters was a high relation in the occurrence of the health symptoms evaluated in this relevant scientific study.

Conclusions

The presence of the air pollutants mentioned above added to the variations of climatic parameters evaluated, was relevant in the occurrence of the health symptoms analyzed, where was evaluated by different zones of the Tijuana city, the correlation analysis, to determine the principal reasons of this complicated situation, and propose some environmental and health programs to avoid the increase of the lung cancer and skin cancer in the population of this industrial city. This was interesting because can have environmental culture programs in this city and can be expanded to other contaminated cities as Mexicali city and some borders cities with the USA.

Declarations

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Competing Interests

The authors declare no competing financial, professional and personal interests.

Consent for publication

We declare that we consented for the publication of this research work.

Availability of data and material

Authors are willing to share data and material according to the relevant needs.

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